

# TERRACES

## *to SAVE the SOIL*

By E. W. LEHMANN and R. C. HAY



Circular 459

UNIVERSITY OF ILLINOIS . . . COLLEGE OF AGRICULTURE  
AGRICULTURAL EXPERIMENT STATION AND EXTENSION  
SERVICE IN AGRICULTURE AND HOME ECONOMICS

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# Terraces to Save the Soil

By E. W. LEHMANN and R. C. HAY<sup>1</sup>

**M**AINTENANCE of a fertile, productive soil is the first requirement of a prosperous and permanent agriculture; yet relatively few farmers in Illinois realize the amount and value of the fertility lost from the soil each year as the result of erosion. Wind and run-off water both cause soil to erode, but wind erosion is not, in general, a serious problem in Illinois. Water erosion, on the other hand, takes an enormous toll each year from the soils of the state.

Originally the soils of Illinois were covered with forests or grass, which shielded them from the beating of raindrops and the erosion of flowing water. A covering of dead leaves and grass kept the soil rich in organic matter and in a good physical condition to absorb much of the rain water and retard the flow of run-off water. But during the past century most of the timber has been cut off and the sod broken on the rolling lands. The soil has been laid bare, and cultivated crops have removed the organic matter. As a result less water is absorbed by the soil, more of it runs off, and the increased volume and velocity of flow down the slopes carries away thousands of tons of fertile top soil from Illinois farms.

About 35 million acres of good farm land, or 10 percent of all cultivated land in the United States, it is estimated has been permanently ruined by erosion during the past sixty or seventy-five years. In Illinois more than 3 million acres are subject to destructive erosion and are suitable only for timber, it has been shown by soil surveys made by the Illinois Agricultural Experiment Station. Some 3 million acres more are subject to serious erosion and are suitable only for orchards, permanent pasture, or timber. Other areas totalling more than 12 million acres are subject to harmful erosion and are suitable for cultivation only under good erosion-control practices (Fig. 3).

The productive power of these 18 million acres of Illinois land that are subject to erosion is rapidly dwindling. Gullies are forming, and every year more land is abandoned so far as farming is concerned (Fig. 2). The greatest single cause of loss of fertility on this land,

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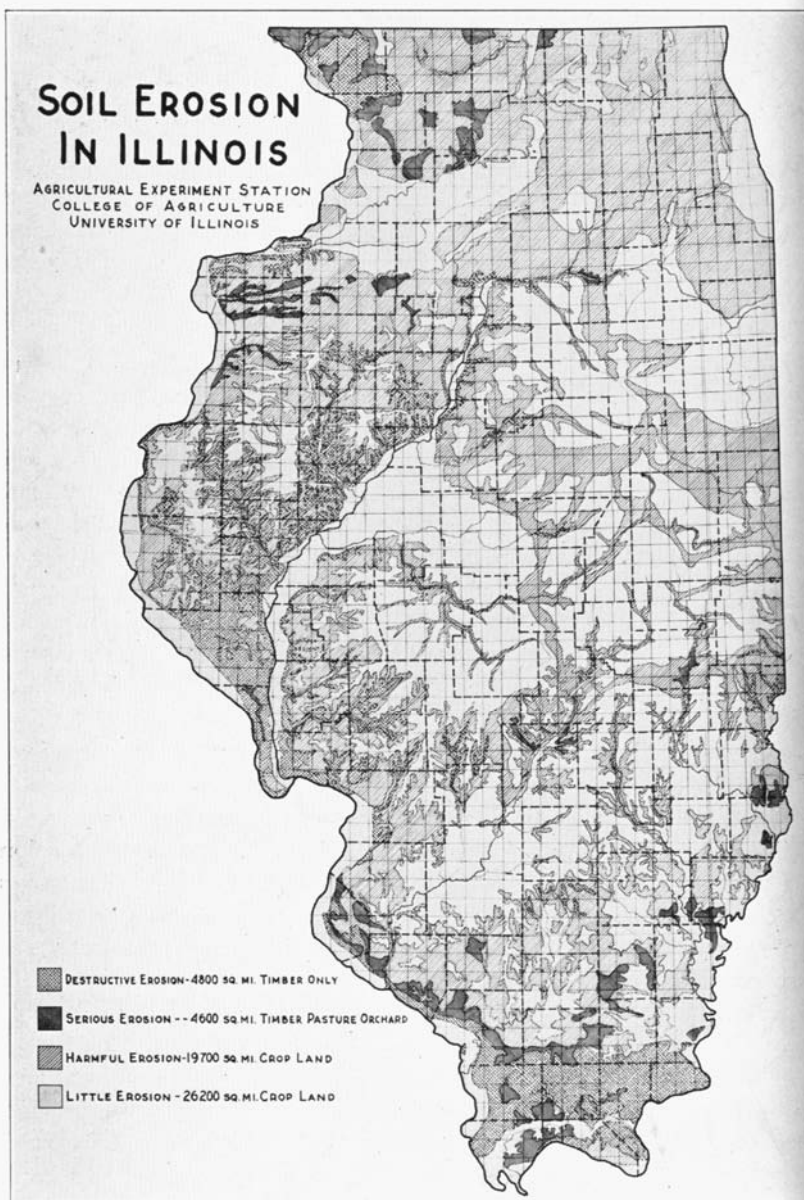


FIG. 1.—WHERE ILLINOIS LAND IS SUBJECT TO EROSION  
Soil erosion is a serious problem in over half of the counties of Illinois.

which includes a large area of the rolling land of the state, is soil erosion. Farmers on such land are coming to realize the problem they face in holding their soil in place and conserving its fertility. Many of them are taking active steps to prevent further damage.

Terraces properly built and maintained are an important aid in holding soil on sloping areas. They are no substitute for other good farming practices that help in saving soil, but are most effective when used in conjunction with good cropping systems and proper soil treatment in an organized plan of farm management—that is, in a soil conservation and improvement program<sup>1</sup> for the farm.

## SOME GENERAL FACTS ABOUT EROSION AND TERRACING

### Two Types of Erosion: Sheet and Gully

Erosion of the soil by run-off water results in two types of soil removal: sheet erosion (Figs. 3 and 4), and gullying (Figs. 2 and 5).

*Sheet erosion* carries away the surface soil to a more or less even depth from whole fields or slopes. Since it is not so conspicuous, and in fact often occurs without being noticed at all, it is not generally considered as serious as gullying; but it is actually more serious, for it gradually removes the fertile top soil. Indeed the greatest losses of fertility often occur before gullying takes place.

*Gullying* cuts deep ditches which divide fields into small, irregular patches that are hard to farm, and rapidly destroys farm land thru very evident, concentrated losses of soil. Gullying frequently begins with an advanced stage of sheet erosion. It can usually be prevented by reducing sheet erosion to a minimum with terracing and other good erosion-control practices which prevent the concentration of run-off water at points where gullies are likely to form.

### Sheet Erosion Controlled by Terracing and Vegetative Cover

Since the amount of erosion depends directly upon the volume and velocity of the run-off water, protective and preventive measures usually include practices which diminish the amount of run-off and

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<sup>1</sup>Soil conservation and improvement work in relation to erosion prevention and control has recently received increased impetus from the activities of the Soil Conservation Service of the U. S. Department of Agriculture. In the coordinated Soil Conservation and Improvement Project involving all interested agencies now set up in Illinois, terracing is one of the practices included and is being advocated wherever it is needed and can be justified.



FIG. 2.—AREAS LIKE THIS ARE TOO STEEP TO CULTIVATE

Note the bad gullies that have formed where furrows were plowed up and down this slope (Pulaski county).

the rate at which it flows over the ground. When the rain water can be absorbed by the soil or can be made to flow away slowly over the surface, there is little erosion.

Soils can be made more absorptive by practices that tend to increase the organic matter, such as plowing under barnyard manure, green manure, and crop residues, or growing legumes and grasses. Contour cultivation and, under some conditions, tile drainage also reduce the volume and velocity of run-off. Soils covered with vegeta-



FIG. 3.—EVIDENCE OF SOIL LOSSES THRU SHEET EROSION

All this rich top soil was washed in here from one field during one rain.

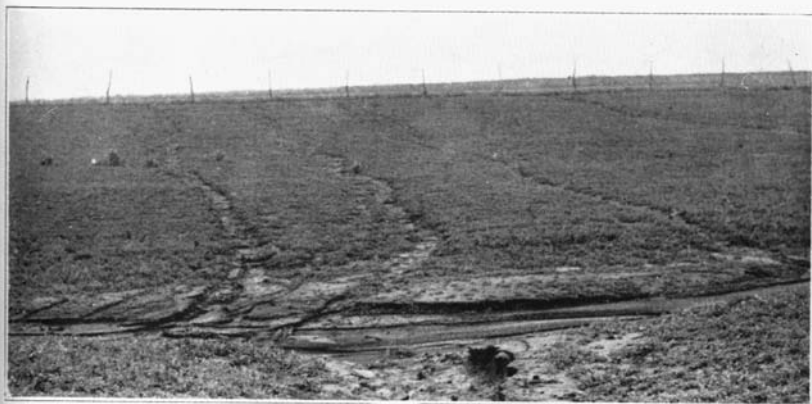


FIG. 4.—DESTRUCTIVE SHEET EROSION, KNOX COUNTY

Terraces would have saved many tons of rich top soil on this sloping field of young alfalfa.

tion are much less subject to the erosive power of run-off water, for plants not only retard the flow of the run-off but their roots bind the soil particles together and open the pores in the soil so that more water is absorbed. All of these production and soil-treatment practices are valuable when properly used in erosion control.

On many sloping fields under cultivation, however, additional protection against sheet erosion is needed, particularly when the soil is

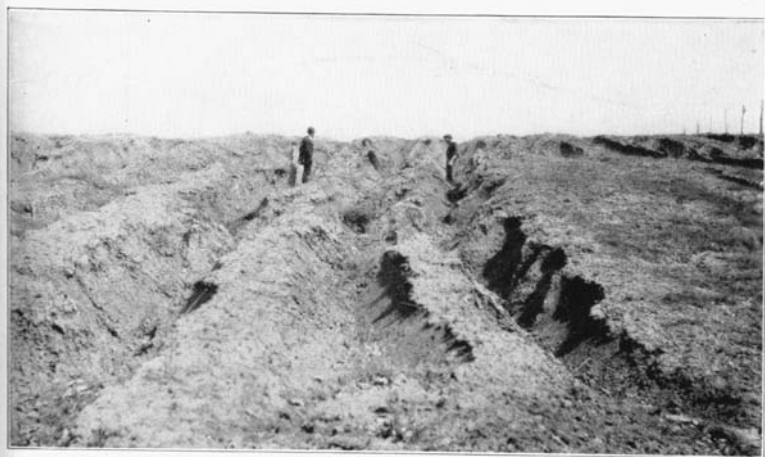


FIG. 5.—THESE DEEP GULLIES WERE STARTED BY CULTIVATION

This land is so badly eroded that it is now suitable only for planting to trees (Johnson county).



left comparatively bare, as in prepared seedbeds, fall-plowed land, new fields of alfalfa, cornfields and soybean fields. It is here that well-maintained terraces have an important place in erosion control, for terraces properly maintained provide permanent protection when vegetative cover alone is not effective. Terraces aid plant growth, not only by saving soil fertility but also by retaining in the soil moisture that would otherwise be lost in run-off. Terraces are doubly effective when proper crop and soil-management practices are employed in connection with them.

The value of terraces in reducing soil losses has been demonstrated clearly by experiments with terraced fields. In erosion experiments conducted by the U. S. Department of Agriculture Soil Erosion Experiment Station at Bethany, Missouri, in 1933, an unterraced field in corn followed by sweet clover lost  $8\frac{1}{2}$  times as much soil by erosion as a comparable terraced field. Likewise, over a three-year period at the Guthrie Soil Erosion Experiment Station in Oklahoma, an average of 30 times as much soil was lost annually from unterraced as from terraced land.

Reports indicate that the first terraces tried in the Middle West to determine their practicability for this section were built by the Illinois Station on the Vienna experiment field in Johnson county in 1906. The corn yields on the terraced portion of this field over a period of ten years averaged more than twice the yield on the check area, where no special treatment was given. Without other special treatment than terracing, the terraced area yielded crops equal to those on an adjoining unterraced area on which eight loads of manure per acre per year were applied during eight of the ten years.

The fact that the experiments at the Vienna experiment field have been discontinued for more than ten years, and that the effects of the work have largely disappeared, detracts in no way from the value of the results, but only shows that without proper maintenance the value and effectiveness of good soil-erosion-control practices can soon be lost.

### **Best to Terrace Before Erosion Is Serious**

It is easier and far more desirable to prevent loss of soil fertility than to restore fertility once it is lost. From the standpoint of conserving the soil, as well as of lower construction costs, it is best to terrace sloping land before serious erosion losses occur. When terraces are built on gullied land, considerable extra work and extra costs are necessary in making earth fills across the gullies. On badly gullied land of low value (Fig. 5) the high cost may make terracing



impractical. Where gullies are beginning to cut back into the slopes on fertile and valuable farm land, however, the expense involved in making deep fills can usually be justified.

### Broad-Base Terrace Best for Illinois

The broad-base, or Mangum, terrace is the type best adapted to Illinois conditions, where it is essential that terraces be built with broad ridges and wide channels so that tractors, multiple-row cultivators, grain binders, and other modern farm machines can be operated on terraced fields. Terraces of this type can be found on thousands of farms thruout the South and Middle West.

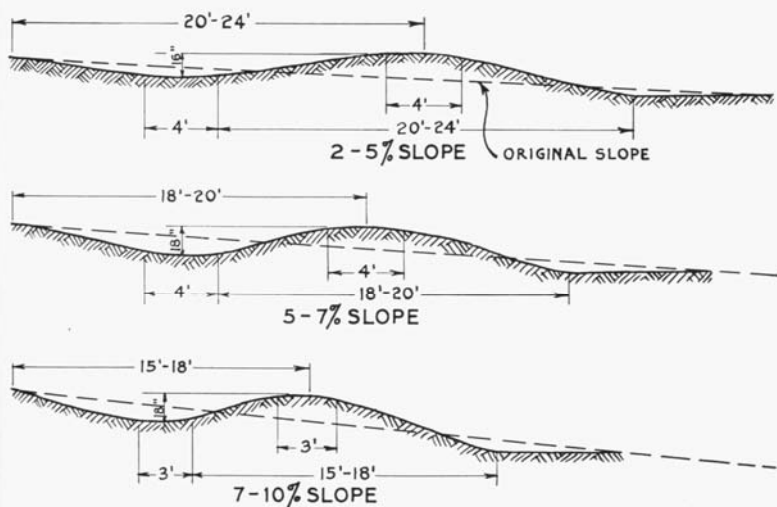


FIG. 6.—CROSS-SECTIONS OF THE BROAD-BASE TERRACE  
RECOMMENDED FOR ILLINOIS

On the steeper slopes terraces must be built narrower and higher than on gentle slopes.

The broad-base terrace is a ridge of earth with a wide flat channel above, constructed to a definite grade. When finished it resembles a graded road across the slope of a field. Dimensions of newly built terraces that meet Illinois conditions are shown in Fig. 6. In some sections of Illinois, particularly in the southern part, where horses and smaller equipment are used, narrower terraces are satisfactory.

### Use Variable-Grade Terraces

The grade of a terrace in Illinois should never exceed 4 inches in 100 feet. Short terraces are usually built with uniform grade, but

terraces longer than 300 or 400 feet are more satisfactory and have a greater capacity when built with variable grade, the grade being reduced at 300-foot intervals from the outlet toward the upper end (see Table 1).

Terraces on more absorptive types of soil can usually be given slightly less grade than terraces on tight soil types. On a few fields

TABLE 1.—PROPER FALL IN VARIABLE GRADED TERRACES

Length of Terrace	Fall in 100 feet	
	Inches	Feet
0 to 300.....	$\frac{3}{4}$	.05
300 to 600.....	1	.10
600 to 900.....	2	.15
900 to 1200.....	3	.25
1200 to 1500.....	4	.30

Note:—Altho the above grades, expressed in inches and in decimal parts of a foot, do not coincide, they are more suitable to use in the field and are close enough for practical purposes.

having sandy, porous subsoil, short level terraces with closed ends are being used successfully in Illinois, but this practice is not generally recommended. Terraces longer than 1,500 feet should have outlets at both ends if possible. When terraces more than 1,500 feet long must drain in one direction, the lower end should be built wider and higher than the recommended terrace cross-section.

### Terraces Particularly Valuable on Cultivated Fields

Fields that are cultivated are benefited more by terracing than are uncultivated fields, for permanent pasture or timber is a natural protection against erosion. Slopes of 3 to 10 percent in cultivated fields are benefited most by broad-base terraces. On very erosive soil, however, slopes of less than 3 percent can be greatly benefited by broad-base terraces; and in hilly sections of deep rich soil, slopes as steep as 12 to 15 percent can be terraced and cultivated safely if a narrow or ridge type of terrace is built. It must be kept in mind that the steeper the slope the more likely are the terraces to break over and fail, especially when the field is planted to cultivated crops. On steep slopes it is well to leave the terraces uncultivated and keep them in sod or some cover crop.

Permanent pastures with slopes as steep as 15 percent have been terraced successfully. Pasture terraces are usually not only built to less width and height (Fig. 7) for economy of construction, but are

spaced at closer intervals than terraces on cultivated fields. Small terraces with ridges of earth, or blocks, thrown up across the terrace channels at frequent intervals are showing good results on pasture slopes.

In some localities orchards are planted on rather steep slopes, some steeper than 15 percent. In terracing orchard land it is best to terrace first and then contour plant the trees. The terraces may be so spaced as to approximate the desired tree spacing, and may be built to a height and width similar to pasture terraces.



FIG. 7.—A PASTURE TERRACE

Terraces on permanent pastures can be built quite narrow, spaced closer than broad-base terraces, and made with very little or no grade.

### Spacing of Terraces Depends Largely on Slope

The best spacing or distance to allow between terraces varies with the slope and to a less extent with the soil type, extent of erosion, and rainfall. Table 2 can be used as a guide in determining the spacing of terraces on different slopes. On open, absorptive soils this spacing, particularly in the northern part of the state, may be increased, but on tight, badly eroded soils of the type that frequently occur in southern Illinois, the space between terraces must be reduced.

### PLANNING THE TERRACE SYSTEM

The planning of a system of terraces requires considerable judgment and foresight. Each field offers new problems and should be given careful consideration before the terraces are built. The project must be practical from the farmer's standpoint, and the engineering must be fundamentally sound. As a rule, more accurate and conse-

TABLE 2.—PROPER DISTANCES BETWEEN TERRACES ON DIFFERENT SLOPES

Slope in feet per 100 feet	Vertical drop between terraces	Distance between the terraces down the slope, feet
1.....	1 foot 9 inches	175
2.....	2 feet 6 inches	125
3.....	3 feet	100
4.....	3 feet 6 inches	87½
5.....	4 feet 3 inches	86
6.....	5 feet	83
7.....	5 feet 9 inches	82
8.....	6 feet 3 inches	78
10.....	6 feet 6 inches	65
12.....	7 feet	58

Note:—The spacings listed in this table are intended for use as a general guide. On erosive timber soils and soils having an impervious subsoil they should be decreased somewhat; and they may be increased slightly on rich, porous, loess soils.

quently better terrace lines are laid out if the farmer has the help of a trained surveyor. But in every case the farmer should be familiar with the plan of the system of terraces proposed for his farm before the construction is started.

The following factors should be kept in mind when making a preliminary study of a field to be terraced:

1. The entire area involved, including any watershed above that drains on the field to be terraced.
2. Outlet possibilities.
3. Adjoining fields that may eventually be terraced.
4. The slope at different points in the field.
5. Soil type in relation to erosion.
6. Approximate length of the terraces.
7. The cropping plan for the field.

### Include Entire Watershed in Terrace Plans

A system of terraces must be located with respect to the top of the slope. In general, the vertical distance from the top terrace to the top of the slope should not be more than the vertical distance between the other terraces in the field. Sometimes water drains across the field to be terraced from a field above. If the area above is small, it may be possible to locate the top terrace so that it does not drain more than 4 acres. When a larger area above is involved, the most desirable solution is first to terrace the upper field. If the upper field is not terraced, a diversion ditch must be built on a non-erosive grade at the upper side

of the lower field to carry the water from above to the side of the field, where it is usually let down thru an outlet that may also serve as a terrace outlet. Where the run-off from above drains thru one or two draws, it may be possible to sod these water courses and use them for terrace outlets.

### **Locate the Outlets**

In studying the area involved in a terracing job, one of the most important things to consider is the location of the proper outlet. Well-sodded permanent pastures and draws or unpastured wood lots that have a thin stand of trees and a tough sod make good natural outlets.

When a suitable natural outlet cannot be found, a wide, shallow, terrace-outlet ditch can be graded down the slope and sodded and, if necessary, protected by permanent dams. When the outlet is graded out, all exposed unproductive subsoil should be covered with top soil before seeding or sodding. Sodded outlets should be prepared a year or more before the terraces are built (see page 15).

Terraces must not be emptied on a public highway unless the terraced land drains naturally on that roadside.

### **Consider Adjoining Fields**

Cooperation among farmers who own adjacent land often makes it possible to utilize to advantage good outlets along boundary lines by draining terraces from both sides.

When terraces for one field are being planned, the possible future terracing of other land on the same farm should also be taken into consideration and outlets located, if practicable, so as to drain terraces from fields on both sides. It is usually not advisable to construct outlets along fence lines or field divisions that are to be changed.

### **Long, Uniform Slopes Best for Terraces**

Fields having long, uniform slopes without abrupt changes, "hog backs," or deep gullies, are best adapted to terracing. Unfortunately the topography of much of the rolling land in Illinois subject to harmful erosion is very uneven, and consequently the terraces on such land often form queer, irregular patterns that are difficult to contour-farm. Sometimes the terrace lines on cultivated fields having very irregular topography, particularly fields having a number of short, steep slopes falling away in all directions, are so crooked and uneven that terracing is of doubtful value.

### **Determine the Soil Type**

Plans for terracing a field may be influenced materially by the soil type. Some soils are much more erosive than others. A yellow-gray timber soil on a relatively gentle slope may be materially benefited by terracing; whereas a similar slope of rich brown silt loam prairie soil might show no evidence of erosion. On more erosive soil types and soils underlain with an impervious subsoil, terraces are generally spaced at shorter intervals and may well be given more grade than terraces on better soil types.

### **Estimate Length of Terraces**

In going over a field it is well to estimate the length of the terraces. This estimate will be an aid in determining the grade to be used when staking the terraces. When it is evident that the terraces will exceed 1,200 to 1,500 feet, it is desirable to locate an outlet near the center, or to have two outlets—one at each side of the field.

### **Know the Cropping Plan**

Crop rotations should be taken into consideration in planning terracing. If possible, fields should be terraced just before they are seeded to alfalfa or clover, for the terraces will then settle and become well established before a cultivated crop is planted on them.

In fields ready to be seeded to permanent pasture, and in need of terracing, pasture terraces (see page 10) may be built more economically than broad-base terraces.

## **PROVIDE ADEQUATE TERRACE OUTLETS**

### **Poor Outlets Are Source of Trouble**

Terrace outlets are the source of more difficulty than any other part of a terrace system. Many farmers who have built terraces have not given enough consideration to the proper location and protection of outlets. As a consequence serious gullies have grown at many terrace outlets, and some of the gullies have grown beyond the farmers' control.

Some of the more common causes of difficulty have been the diversion of water from terraces onto steep slopes, into small, narrow ditches, onto areas not properly covered by sod, or over vertical banks or heads (waterfalls) in the outlet (Fig. 8). Failure to maintain the outlets properly is also a frequent source of trouble, even when the outlets have been properly planned and prepared.

### Control Outlets Down to Established Channels

Other conditions being favorable, the terrace outlet should be located along that side of the field having the least slope, for on that side there will be less danger of a gully starting. In locating an outlet it is important to follow its course down the slope to the point



FIG. 8.—SERIOUS OVERFALL EROSION IN A TERRACE OUTLET AT A ROADSIDE

To prevent further damage, a sodded outlet has been built within the terraced field (Williamson county).

where it enters an established drainage channel. When there are serious heads or waterfalls over which the water will flow, concrete or masonry dams may be required to prevent gullies cutting back up the hill. Under such conditions choose another suitable outlet location if possible, so that the water may be diverted from the heads by the terraces.

### Prepare Outlet Ditches Before Terracing

When an outlet ditch must be constructed and sod established to prevent erosion, the sod should be established before water from the terraces is emptied into the outlet, in order to reduce the danger of serious gullying. This necessitates preparing the outlet a year or more before terracing, or diverting the water temporarily into an adjoining field that has a good cover of sod.

Sodded outlet channels require a bottom width of not less than 8 feet to facilitate mowing (Fig. 9). Widths as great as 25 feet are



permissible when areas as large as 15 to 20 acres are drained by one outlet. Depths of flow may vary from 4 to 12 inches. Outlets on steeper slopes require channels of greater width and less depth, in order to spread the flow of water over a larger surface and hold it below an erosive velocity.

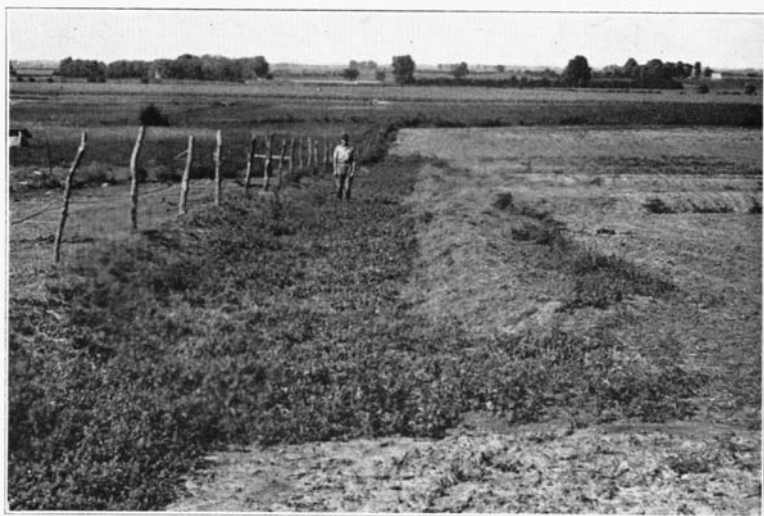


FIG. 9.—A WELL-SODDED TERRACE OUTLET DITCH ALONG THE  
EDGE OF A FIELD

Terraces enter this outlet from the right.

### Offset Outlets Into Pastures and Wood Lots

When terraces discharge on a pasture or in a wood lot, offset the ends of the terraces, if possible. That is, carry the top terrace farthest out, and stop each succeeding terrace down the slope at least 25 feet short of the one above it. Water flowing out of the terraces constructed in this manner will not be concentrated on one narrow strip as it flows down the slope.

### Build Adequate Outlet Structures

On moderate slopes where the drainage areas are small, sodded terrace outlets so constructed as to hold the velocity of flow to a point low enough to prevent erosion (generally considered below 4 feet per second on good sod) usually need no special structures built to protect the outlet channel. If vertical drops occur in the ditch or at its mouth, however, permanent structures may be required.

In terrace outlets draining large areas, or located on steep slopes

or at heads or vertical drops, permanent dams of rubble masonry or reinforced concrete are required (Fig. 10). Structures of this type should be carefully designed so as to have an adequate weir notch (opening for water flow), head walls extending well into the side banks, and an apron with suitable wing walls to prevent cutting at the overfall. The grade between structures should not exceed a fall of  $\frac{3}{4}$  foot in 100, with  $\frac{1}{2}$  foot in 100 preferred.

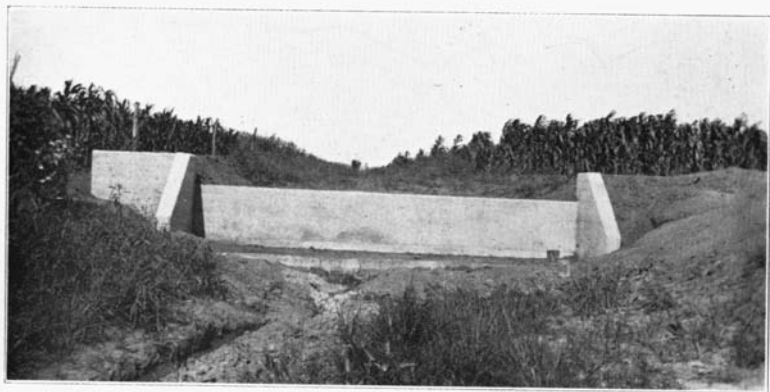


FIG. 10.—A TERRACE OUTLET DITCH PROTECTED BY A REINFORCED CONCRETE DAM

Structures of this type to be successful must be so designed as to have an adequate weir notch, head walls extending well into the side banks, and an apron with suitable wing walls to prevent cutting at the overfall (Jersey county).

In some places where earth fills must be built as a part of a terrace across gullies, a line of tile may be laid in the gully to take care of the water that will otherwise stand until it evaporates or seeps away. Ordinarily under these conditions, if the slope of the tile in the gully is more than 3 percent, it is necessary to use sewer tile, since farm drain tile would wash out. Second grade, or cull, sewer tile can often be secured for an outlet of this kind at no greater cost than farm drain tile.

## LOCATING AND MARKING THE TERRACES

### Equipment for Staking Not Expensive

Equipment needed for staking out a terrace includes a light drainage level or farm level, a level rod, a hatchet or hand ax, and a number of stakes for marking the terrace line. When several farmers in a community have terracing to do, a complete outfit may be purchased on a cooperative basis involving only a small outlay

by each person. A farm level and rod satisfactory for terracing can be bought at a cost as low as \$20. Use of a better quality instrument, however, speeds up the work and is recommended for anyone who does considerable staking of terraces.

The actual number of stakes needed will depend upon the length of the terraces and the unevenness of the ground. Stakes usually are set at 50-foot stations; but at bends, across draws, and around points it is desirable to set them at 25-foot intervals. Plaster lath are satisfactory stakes. They can be used full length, pulled and used over again a number of times.

Two men are needed to stake out a terrace. One handles the level and the other holds the rod, moves the target, steps off the distances between points where readings are taken, and sets the stakes (Fig. 11).



FIG. 11.—STAKING OUT A TERRACE WITH AN ENGINEER'S LEVEL, BOONE COUNTY  
This type of level is recommended for speed and accuracy.

### Locate Top Terrace

After the outlet has been chosen, the high point of the area located, and the approximate length of the terrace determined, the slope of the area can be measured and the top terrace staked out. The slope is measured by setting up the level and taking a rod reading at the top of the slope, and then pacing 100 feet down the slope and taking another rod reading. The difference between the two readings gives the percent of slope, or fall in 100 feet. When there is considerable variation in slope, several such measurements are made in order to determine the most common or controlling slope. This per-

cent of slope is used to determine the vertical spacing of the terraces, as given in Table 2, page 12.

Usually the top terrace line is staked out first, as a trial line which may require restaking several times before it is finally located. It is often desirable to restake the top terrace so that it intercepts heads of small gullies or runs above areas showing evidence of sheet erosion. In rich, porous soils showing no appreciable erosion at the top of the slope, the top terrace may be located farther down the slope than indicated in Table 2, provided that an area not exceeding 4 acres is drained. One must be sure the location of the top terrace line is satisfactory before locating terraces below it. When a steep slope starts in a field locate the first terrace just above the break.

If there is an obstruction of some kind in the field—a sink hole, a tree, a deep gully, or a large boulder—it is often best to stake first a lower terrace just above or below this obstruction. The other terraces are then located with reference to this one.

### Stake Out the Terraces Carefully

*Start at the Outlet.*—Unless the high point or some other controlling feature is as far as several hundred feet from the outlet, the outlet is the best point at which to start staking out a terrace. Normally the best starting point is the one that will result in the best spacing thruout.

The level, if it is of good quality, can be set up 300 or 400 feet from the outlet, so that a number of stakes can be set before moving it. A rod reading is then made on the high point when staking the top terrace, or on the outlet stake of the terrace above when staking lower terraces. The vertical spacing, as determined from Table 2, is added to this reading to locate the outlet stake of the next terrace below. The rodman raises the target to make this addition and moves down the slope until the instrument man sights on the target. A stake is set here. The rodman lowers the target to give the proper grade, paces 50 feet in the general direction the terrace line will follow, and moves the rod up or down the slope as directed by the instrument man until the desired elevation is located. The second stake is set here.

Some figures will illustrate the foregoing instructions for the use of rod and level: If the rod reading at the high point is 2 feet 6 inches, and the controlling slope has been found to be 4 percent, the proper vertical spacing, 3 feet 6 inches (Table 2), is added to give a rod reading of 6 feet at the outlet stake. If a grade of 3 inches in

100 feet is desired, the target is moved down  $11\frac{1}{2}$  inches to 5 feet  $10\frac{1}{2}$  inches for locating the stake 50 feet from the outlet. In other words, the second stake is set at a point  $11\frac{1}{2}$  inches higher than the outlet.

(More complete information on the use of a level in staking out terraces may be secured by writing to the Department of Agricultural Engineering, University of Illinois, for a mimeographed circular "Directions for Laying Out Terraces.")

*Move Instrument When Sights Are Long.*—Stakes are located in the manner described in the foregoing paragraphs until the rodman has moved away from the level a maximum distance for accurate readings. (It is not good practice to use a farm level for taking sights longer than 200 feet; with a better quality level sights of 400 feet or more may be taken). Then it is necessary to move the instrument. The rodman holds the rod at the last located stake while the level man moves the level to a new location past the rodman along the terrace line and sets it up again. The rodman then moves the target until sighted again by the level man. Additional stakes are located with reference to this stake as if starting at the outlet again.

In staking the next terrace and succeeding terraces below, it is usually best to measure the slope again at several points. These slope measurements may be taken while walking back to the outlet from the upper end of the terrace just staked out. By this method the instrument man has the necessary data for staking the next terrace when he reaches the outlet.

*Judgment and Accuracy Required.*—Responsibility for the accuracy of the work in staking out terraces rests with both the instrument man and the rodman. Care must be taken to see that the bubble is centered before each reading is taken. The level should be checked frequently and kept in proper adjustment. The judgment and care of the rodman determines to a large extent the accuracy of the grade and location of the terraces. Since readings are taken on the ground, it is important that the rod always be set on average ground surface and not in depressions or on high spots.

*Cross Gullies With a Smooth Curve.*—When a terrace is to be constructed across a draw or gully, set the stakes to form a smooth curve bending up the slope at the gully, somewhere between the grade line and a line straight across the gully (Fig. 12). Never run the line so as to form a V-shape. Terraces can frequently be staked approximately straight across narrow gullies.

In no case should the grade of a terrace ridge leading into a draw or gully be greater—and preferably it should be less—than the grade leading out toward the outlet. If possible, the terrace grade should be increased as it leaves the gully. Terraces having outlets at both ends can sometimes be staked to drain in both directions from a gully or a bend near the middle of the field.

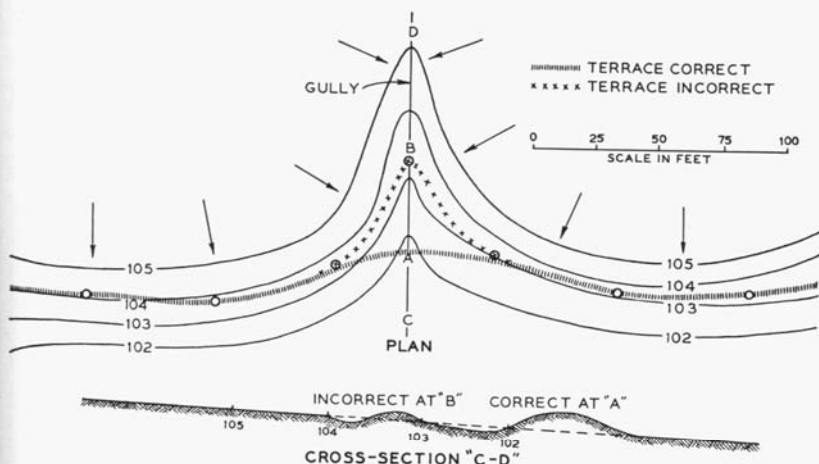


FIG. 12.—WHERE THE TERRACE SHOULD CROSS A GULLY

In crossing gullies it is better to construct terraces almost straight across than to follow the grade line.

### Walk Out and Plow the Lines

After a terrace is staked, the short bends should be eliminated. In doing this the man in charge of the work walks along the terrace line and smooths out minor variations by moving stakes in order to make the terrace line follow long curves. Stakes may be moved farther in straightening terrace lines on gentle than on steep slopes.

Unless the terracing machine is in the field ready to start the terraces, each terrace line should be marked out with a plow following the walking-out and eliminating of sharp bends.

## CONSTRUCTING THE TERRACES

### Build Terraces to Proper Size

The building of good terraces requires the moving of a considerable quantity of earth and usually involves the expending of more time and power than inexperienced persons anticipate. Farmers

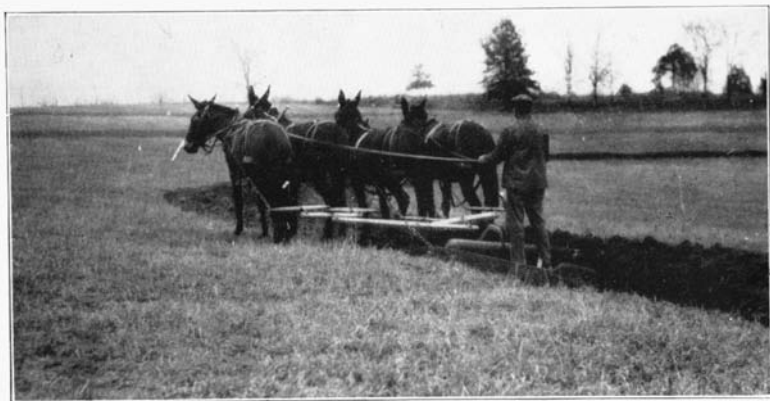


FIG. 13.—BUILDING TERRACES WITH A V-SHAPED STEEL DITCHER,  
WABASH COUNTY

Terraces have been built successfully with a plow and a V-shaped steel ditcher, but it is a slow process to construct them that way.

who attempt to build their own terraces often stop before the terraces are built to sufficient width and height to function properly.

Dimensions recommended for terraces in Illinois are shown in Fig. 6. In the southern part of the state, however, terraces usually are not built quite as wide as the dimensions shown in Fig. 6. Some farmers have built terraces smaller than those recommended, and have gradually increased the size by contour plowing and maintenance



FIG. 14.—BUILDING TERRACES WITH A ROAD GRADER, SCHUYLER COUNTY  
Road graders, if in good condition, are satisfactory for terracing.



with a drag or small grader each time the field is plowed. After a few years the terraces have attained proper dimensions. This practice of building to smaller size and depending upon maintenance measures to correct the size is not, however, generally recommended.

Experience in building terraces will reduce the number of rounds required to build a good terrace, and will thus keep down the cost. The cost of terracing varies widely with the nature of the land and the equipment used. With experienced operators and an efficient terracing machine, terracing moderate slopes that are free from gullies is often said to cost about as much as plowing the land once.

### Use Suitable Terracing Machinery

Machines designed especially for terrace construction are most desirable for this work, altho equipment of other kinds found in most communities can be adapted to terracing (Fig. 13). Road graders (Fig. 14), V-shaped steel ditchers, and V-drags and plows have been used to build terraces in various sections of Illinois, but at best they are slow and inefficient. Large highway graders and crawler-type tractors throw up earth rapidly but lose considerable time in turning.

Small blade terracers pulled by farm tractors or horses build terraces quite satisfactorily (Fig. 15). Such machines are sometimes owned cooperatively by several farmers in a neighborhood. By providing their own power and labor, farmers can terrace at a com-



FIG. 15.—BUILDING TERRACES WITH A SMALL BLADE TERRACER,  
MADISON COUNTY

Satisfactory terraces have been built with machines of this type pulled with four horses or a farm tractor.

paratively low cash cost. When large acreages are to be terraced and the investment can be justified, the large 9- and 10-foot blade terracers pulled by 35- or 40-horsepower tractors can be used to build terraces (Fig. 16) at a lower total cost and more rapidly and satisfactorily than any of the smaller blade machines.

Two new terracing machines, operating on principles quite different from the blade terracers, are now in use. One, developed at Iowa State College, is made up of a plow and a spiral rotor driven



FIG. 16.—CONSTRUCTING A BROAD-BASE TERRACE WITH A 10-FOOT BLADE TERRACER PULLED BY A 40-HORSEPOWER TRACTOR

Terraces are built better and considerable time is saved by using equipment of this type. The overhead expense, however, is high.

from the power take-off and used to throw earth in building the terrace (Fig. 17). The other machine, developed at the University of Missouri, is a small-size modified elevator grader, driven by power take-off from the tractor (Fig. 18). Both of these machines show promise in building terraces economically, because of relatively low power requirements and high capacity for doing work.

### Building the Ridge

In starting to build a terrace with a grader or blade terracer, make the first cut with the point of the blade at the stake line, throwing the earth down hill. On the return trip move a cut up hill toward the ridge made by the first cut. Let this ridge thrown up by the two cuts be the center of the terrace ridge. By this plan the lower edge of the terrace channel, and consequently the grade of the channel, will follow the stake line.



FIG. 17.—THE IOWA TERRACER IN OPERATION

This machine builds a terrace by throwing earth with a helical drum after it is loosened by a moldboard plow.

In using a grader or blade terracer, leave as wide an undisturbed area under the center of the ridge as practical, for it is undesirable to move earth from that section where a fill is required. This undisturbed width varies with the size and type of terracing equipment used.

A high narrow central portion of the ridge should be built up in the first few rounds, for earth can be moved more efficiently when the point of the blade is cutting undisturbed earth at all times. The terrace is completed by moving dirt against it from both sides and cutting a wide channel above the ridge.



FIG. 18.—THE MISSOURI TERRACER IN OPERATION

This machine is a small elevator-grader designed for terrace building.

On slopes up to 6 percent, build terraces by moving earth from both sides; on steeper slopes most of the earth can be moved more economically from the upper side, only enough work being done from below to smooth up and slope the lower side of the ridge.

Avoid making a channel on the lower side of the terrace ridge, for water would accumulate there, break over and cut small gullies down to the next terrace.



FIG. 19.—A BROAD-BASE TERRACE OF GOOD DIMENSIONS  
Oats are seeded in the field.

*Always build the top terrace first* regardless of which terrace is staked out first. The top terrace must be well constructed, for the safety of the lower terraces depends upon its success. If only a limited amount of time can be spent in terracing, it is much better to build the two upper terraces well than to build four or five carelessly or inadequately.

The completed terrace ridge should be 16 to 22 feet wide and 16 to 18 inches higher than the channel, which should be approximately the same width as the ridge (Fig. 19). The crown of the terrace ridge and the bottom of the channel should have widths of about 4 feet. Terrace cross-sections that meet the requirements of Illinois conditions are shown in Fig. 6. After settling, the ridge should at no point be less than one foot high.

### Fills Across Gullies

A slip scraper, fresno, or rotary scraper is needed to build the terrace ridges across gullies. These fills must be made sufficiently wide and high so that they will not break. Failure to build fills properly is one of the most common causes of the failure of terraces.

The fill should be built about 20 percent higher than the ridge on each side to allow for settling.

### Always Check the Terraces

A terrace must not be considered completed until it is checked. In checking, use the level and rod and take readings on the ridge and in the channel at every 50-foot station and at noticeable intermediate high and low spots (Fig. 20). High spots in the terrace channel and low spots on the ridge should be marked and corrected to assure the flow of water in the direction desired.



FIG. 20.—CHECKING THE GRADE OF A NEWLY BUILT TERRACE

A terrace should not be considered complete until the grade has been checked. This terrace is constructed along the stake line shown in Fig. 11.

When additional work needs to be done over several hundred feet, it can best be done with the terracer. Short deep cuts and fills can usually be made more economically with a fresno or a slip scraper.

### SUCCESS OF TERRACES DEPENDS ON MAINTENANCE

The necessity for intelligent maintenance of terraces cannot be stressed too emphatically, for no system of terraces, however well planned and constructed, can be successful over a period of years unless kept in good repair.

It is not difficult to keep terraces in good condition if they are watched carefully and if needed repairs are promptly made. Without proper maintenance, the benefits derived from terracing, as well as the investment in construction, can soon be lost. Some terraces rather poorly planned and not properly built have been notably



FIG. 21.—A WELL-MAINTAINED TERRACE PROPERLY PLOWED  
This field has been terraced for nearly ten years (Richland county).

successful because of the farmer's persistence in repairing and maintaining them. Hence it may be said that responsibility for the success of terraces on cultivated land rests upon the man who farms the land (Fig. 21).

*First Year Is Most Important.*—During the first year, when the ridges and fills are settling, terraces should be inspected after each heavy rain so that if any breaks occur they can be repaired with a shovel before serious damage is done. The points needing most attention are the gully fills, bends, and the outlet ends of the terraces. Maintenance at these points is especially important if the field is planted to a cultivated crop the first year.

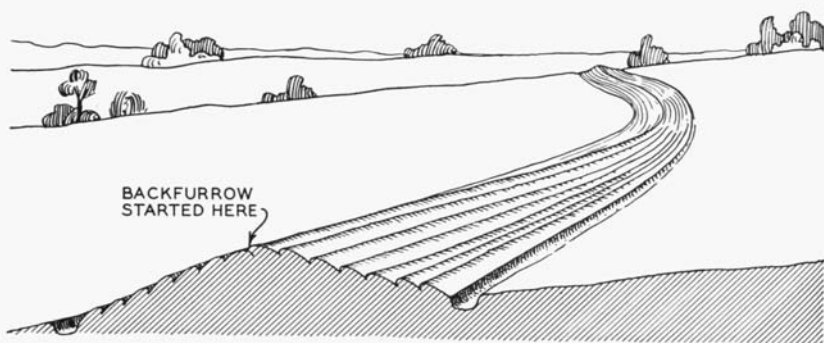


FIG. 22.—A TERRACE RIDGE PLOWED BY BACKFURROWING TO THE  
CENTER OF THE RIDGE

This practice tends to build up and widen the ridge.

*Watch the Outlets.*—The outlet ditch also should be watched so that prompt measures can be taken to stop any serious washing that may occur. A good sod should be maintained in the outlet ditch and in the lower 15 to 20 feet of the terrace channel. Sod strips can be laid in any small gullies that start cutting in the outlet. Any breaks or leaks around permanent dams must be filled and tamped tightly before they become serious, or the structure may be washed out and the entire outlet endangered.

*Backfurrow to Ridge When Plowing.*—Once a terrace is well established, it requires little attention other than back furrowing to the center of the ridge each time the field is plowed (Fig. 22). This practice tends to build up and widen the ridge.

It is also necessary to keep the channel cleaned out. A round or two with a small grader or a homemade V-drag (Fig. 23) in the channel following plowing leaves the terrace in good condition.

## FARMING TERRACED LAND NOT DIFFICULT

Many farmers do not favor terracing because they believe the terraced land will be difficult to farm. Farming terraced land is not difficult once the farmer is willing to give up straight rows and try contour farming. And, at any rate, terraces not only save soil but are much less objectionable to cross than gullies. The inconvenience experienced in following rows planted along the terraces, in farming point rows, and in crossing terraces with haying and harvesting machinery is well repaid by the increased crop yields that are obtained as a result of the soil fertility that is saved.

*Contour Farming Best Practice.*—Contour farming,—that is plowing and planting rows across the slope parallel with the terraces,—is the most desirable farming practice on terraced land. When this method is used, each row acts as a miniature terrace and tends to conserve moisture and check any erosion that might occur between terraces. On cultivated land steeper than 5 percent, contour farming is necessary if the terraces are to be reasonably successful. Altho contour farming is the better practice, even on slopes of less than 5 percent, terraced land with this slope can be successfully farmed in straight rows if greater care is given to the maintenance of the terraces.

In plowing terraced land on the contour, a back furrow is started on top of each ridge and the land between terraces is plowed out on



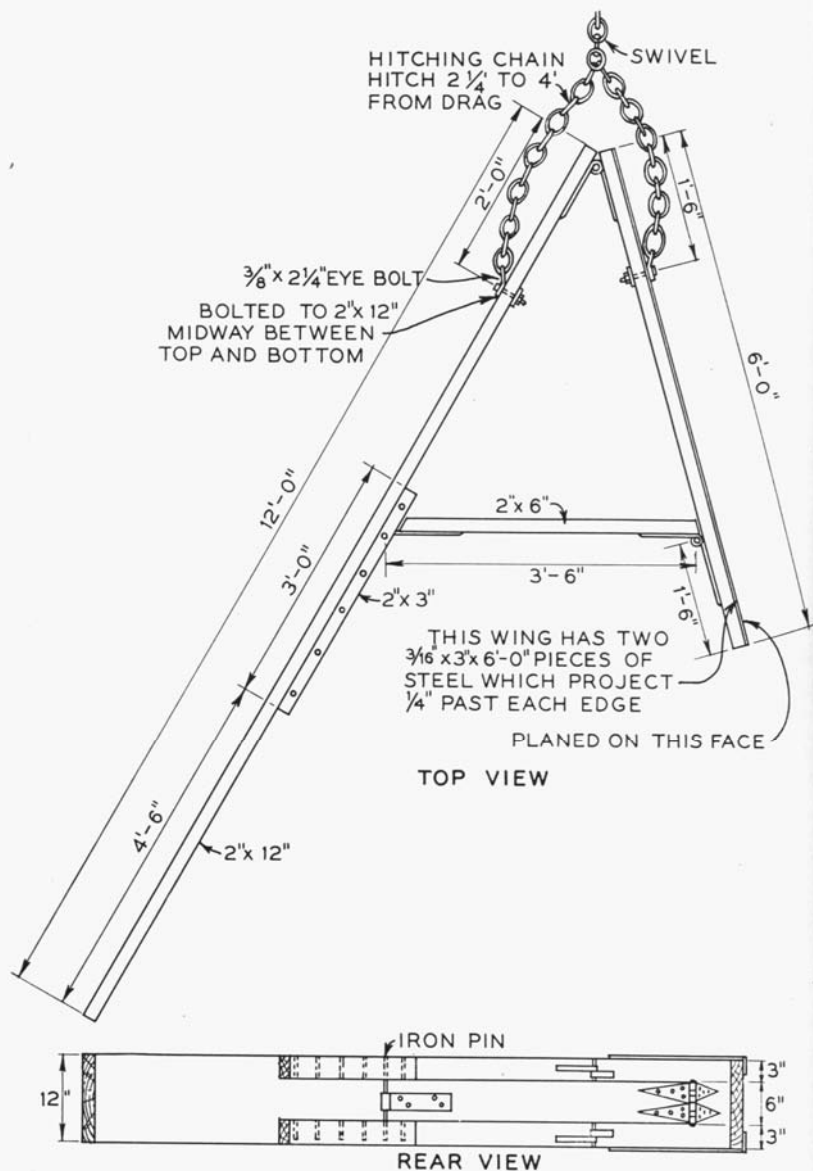


FIG. 23.—DETAILS OF THE HOMEMADE V-SHAPED DRAG

Altho this tool has been used for terrace construction, it serves a better purpose in maintaining terraces.

the contour. On slopes of less than 5 percent the field can be plowed in regular lands, if one is careful to lift the plow out of the ground in crossing the terraces. After the field is finished, the terraces may then be plowed separately in the manner described above.

*Corn Rows Should Follow Terraces.*—Contour planting of corn requires that the corn be drilled parallel with the terraces (Fig. 24). One of several plans may be followed. One plan is to choose the straightest terrace in a series of terraces as a "key" terrace, and to plant all the corn rows parallel to that one, crossing the other terraces when necessary. Another plan is to plant from the top of each terrace ridge down the slope to the next terrace, turning in the channel of that terrace in planting the point rows. A modified plan of strip cropping may be followed by seeding down the point-row areas and the terraces to a hay crop, thus eliminating the cultivation of point rows.



FIG. 24.—A TERRACED FIELD PLANTED ON THE CONTOUR, McLEAN COUNTY

Note the corn rows following the terrace ridge in the foreground, and the point-row areas planted to a hay crop in the left foreground and the right background.

## EROSION

is a serious problem on more than 18 million acres of Illinois land. Terracing and good soil and crop practices on slopes not too steep nor too seriously eroded, and pasture or trees for the steeper slopes, are the solutions for the problem in Illinois.

Study, experience, and good judgment are all required in planning a terrace system. Outlets must be well placed and designed. The staking of the terrace lines, the building of the ridges, and the checking of the terraces must all be done with care and accuracy.

After terraces are built, they must have good care. Breaks must be repaired promptly, each ridge backfurrowed in plowing, channels kept free from obstructions, and contour farming practiced.

For economy in construction and for benefits received, terraces should be built before erosion becomes serious. Better yields of crops and a more secure future are the rewards for intelligent terracing and terrace maintenance.

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